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ABSTRACT

Transfer of instructional technology is the last step in the knowledge cycle, preceded by invention, technical and commercial development, and dissemination. Technology includes both equipment and the practical knowledge needed for application. Industrialized nations package technology; however, little practical knowledge is transferred with packages. The knowledge remains with the originator or imported technical staff, maximizing short-term implementation. Without adaptation, however, long-term failure is probable. Instructional development is generally described as a systematic decision-making process. In practice, the process has frequently been an effort to develop a convergent, closed system. Such systems appear clear and unambiguous, appeal to administrators and funding sources, and are efficient in controlled settings. Transferring technology to new settings may require an alternative instructional development process that makes fewer assumptions about outcomes. Such a process would assume that technology will evolve in an open system in a kind of reinvention cycle.
Development-as-reinvention appears less exact and is more expensive in implementation. In return, it offers a higher probability for long-term success. Finally, through a gradual socialization of the technology and the recipient, it offers opportunities to examine second-order consequences. Policy implications for funding agencies include recommendations for small pilot projects and long-term developmental funding. (Author/LMM)

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TECHNOLOGY TRANSFER

AND

INSTRUCTIONAL DEVELOPMENT

A PAPER

PRESENTED AT

THE NATIONAL CONVENTION

ASSOCIATION FOR EDUCATIONAL COMMUNICATIONS & TECHNOLOGY

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AND
INTERNATIONAL DIVISION

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BY

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ABSTRACT

TECHNOLOGY TRANSFER
AND
INSTRUCTIONAL DEVELOPMENT

Robert E. Holloway
AECT Dallas 1982

The transfer of educational technology is the last step in the knowledge cycle. It is preceded by invention, technical development, commercial development, and dissemination. "Technology" is more than equipment. It also includes the practical knowledge needed for application. Industrialized nations tend to "package" technology. Little practical knowledge, such as adaptation or repair, is transfered with such packages. The knowledge remains with the originator or imported technical staff, it is centralized, and oriented toward its source. This maximizes short term implementation, but with little flexibility and adaptation, long term failure is probable.

Instructional development is generally described as a systematic decision-making process. In practice the process has frequently been an effort to develop a convergent closed system. Such systems appear clear and unambiguous, appeal to administrators and funding sources, and are efficient in controlled settings. Transfering technology to new settings may require an alternative instructional development process that makes fewer assumptions about outcomes. Such a process would assume the technology will evolve in an open system in a kind of "reinvention" cycle.

Development as reinvention appears less exact and is more expensive in implementation. In return is offers a higher probability for long term success. Finally, through a gradual socialization of the technology and the recepient, it offers opportunities to examine second order consequences. Policy implications for funding agencies include recommendations for small pilot projects and long term developmental funding.

Technology Transfer 1

Physical or Behavioral Technology 2

Transfer Traps 4

Intranational and International Transfer 7

Changing the System 9

Instructional Development 11

Development as Reinvention 14

Policy Implications 18

Appendix A

References

Technology Transfer and Instructional Development

The transfer of technology from one user to another occurs after the technology has been developed. The entire process is sometimes called the "knowledge cycle" (Rich, 1981) and starts with invention. After invention, the technology is demonstrated, perhaps in a laboratory or experimental setting, and then developed commercially for production and dissemination (cf. Rosenburg, 1976). After the initial dissemination the technology may be "transferred." Some cycles are very long: steam power took about two thousand years. Other cycles are, especially now, relatively rapid: the hand held calculator took less than ten years. Cycles frequently are interrupted, sometimes permanently, while others reinforce each other to produce more than the individual parts, such as the intelligent videodisc.

The cycle may be convergent and inherently limiting. Technical development for a purpose, even if that purpose is hazy, such as a "computing engine," selects and emphasizes those functions that correspond to apparent needs. There are biases in the development of technology (Stewart, 1979). The process does not develop alternative functions, though there may be happy accidents. The tremendous effort that goes into the research and development process may not be replicated in the transfer process. Utterback (1974) found costs for adaptation in transfer as great as the original research cost for industry: educators prefer to consider transfer a method of decreasing initial costs...an assumption that may be in error for successful transfer. If the

application is similar, the selective development problems are minimal. If, as is often the case, the situation differs in important respects the transfer may work only at the mechanical level. For example, Dial Access Systems in education were made possible by telephones and switching equipment, but appear to have been abandoned for now, not for technical reasons, but because they did not fit the current practice in schools and took more effort than they offered benefit.

Physical or Behavioral Technology. The nature of the technology appropriately begins with the physical technology, the equipment. However, instructional technology clearly encompasses the process and knowledge aspects as well. Ely (1970) separates the equipment as a "physical science" (devices) of instructional technology in contrast to a behavioral science concept of instructional technology. Gooler (1979) elects the "process" technologies as the basic concern in transfer. Among instructional developers the process conception of instructional technology is more popular. Process innovations and transfer may be more frequent than physical or product changes in education. Process changes are more frequent in industry (Utterback, 1974). However, transfer of process would occur primarily among instructional technologists rather than between instructional technologists and others, such as government officials.

The equipment or product in some physical form would appear to preceed process in most innovations in instructional technology. Potential adopters focus on the physical science products....television systems,

computer, cameras, books, satellites, cable. While decision makers perhaps should go beyond this, seeking "hard" research-based knowledge, it is a reasonable assumption that decisions are made on soft "knowledge of social impact of policy" by those at the national level (Caplan, 1977). Product technology (equipment) informs the decisions rather than process technology...its existence is the evidence of feasibility.

To understand the transfer process it is important to understand this viewpoint of the potential adopter. If the adopter perceives instructional technology as a physical science, the transfer unarguably starts there. This is one of the few objective events in transfer and provides a common ground from which to examine values and process. Generally an objective agreement can be obtained that a device exists. Most subsequent conclusions about process are magnitudes higher in inference and are better described as speculations if their predictive power is the measure of their worth.

If it is granted that the inferences about process technology in transfer are tentative at best, the value of an anchor point in the physical existence of equipment is that it may help understand differences in process. Subsequent development, the "use" of the equipment, is cultural change, the modification of reality (Casse, 1980) and the heart of such dilemmas, McAnany (1978) suggests, is that values are involved. "In this sense, any educational change/innovation is more than a program to educate learners. It also is a social phenomenon created by participants" (Everhart & Doyle, 1980).

This is an imposing milieu to understand. Further, control of such complex events for specific positive outcomes is negligible. This imposing complexity supports the need to conservatively define the initial instance of technology in the transfer process as a physical referent. This is not at the expense of process technology: it simply provides a solid rock in the changing cultural sea. As an attempt at parsimony, "equipment" will be used as the necessary, if not sufficient, condition effecting technology transfer in this discussion.

Transfer Traps. The problems of transfer make up a miniature catalog of the difficulties of human affairs. A few are identifiable as persistent, almost inevitable. Others are evidently exacerbated by particular setting differentials such as industrialization. One of the tacit beliefs that has been a common source of failure is that "technology is a panacea for national woes" (Hala & Martin-Harris, 1978). In addition to the doubtful potential of technology to solve national problems, the implementation is confounded by lack of "attention to intervening contextural factors" (McAnany, 1978). The technology can fail on two counts: (1) the limited intents of the original purpose and, probably, (2) the goals of the adopters.

Pressing social problems, political forces, and economic pressures create needs for "off the shelf" solutions. Expectation that a solution will work if the equipment works are supported by selective perception and selective dissemination of information by those involved. There is little "systematic evaluation that might prove risk takers wrong and

and dampen the satisfying ardor of the mutually converted" (Miles, 1964). Knowledge about technology may transfer and be used for decision making without the transfer of utilization knowledge.

A related knowledge problem is evident in the transfer of "packages." These large scale systems, both in industry and education, are usually produced outside the setting in which they will be used. The production is done in a location that has the industrial resources and people with specialized knowledge and skills available. This is an efficient method of production since the capital investment needed is prorated over the manufacturer's clients. The system arrives integrated and, in terms of contract requirements, can be operational in a short time. This appeals to the economics of social programming and, perhaps, short term political needs.

The packaging of technology increases with its complexity (Stewart, 1979). Clearly the more packaged a technology is, the less knowledge needs to be transferred for initial use. Too, the packaging separates the producer's knowledge from the user's setting...it is not available unless another phase of transfer is undertaken, one that is both expensive and time consuming. A short term solution is the hiring of outside consultants. This or intensive training for a recipient cadre, keeps knowledge centralized and is a well known barrier to both adaptation and dissemination. Fortunately, at the national level there is growing sophistication in selection and capacity building. At the local

level, however, transfer is still frequently equipment without user or producer knowledge.

Equipment transferred without much knowledge may still be used, sometimes with dramatic improvements, occasionally in very different ways than intended. More often it is neglected except for symbolic use. This suggests one important difference between transfer of technology in industry and education. In industry the ability to produce is sought In education the product is sought: little capacity is added with its transfer. This leaves education in the dependent role and, with extensive transfer, even more dependent than before.

Problems such as electrical current differences, moisture, repair, and so on are often cited as barriers to transfer. While these are real problems they are also relatively easy to deal with. They can be identified and solutions are usually available. When advanced as reasons for not using equipment, it might be more fruitful to consider other causes for discontinuance. High on the list are problems of perceived advantage in using the equipment. If, for instance, television sets in the classroom do not work, compare sets in other locations. Are sets in the home working? In bars? If there is a difference, the problems could be solved at the mechanical level. The barriers, however, are more likely organizational or individual as a function of values. The implication that, from the recipient's viewpoint, it is not worth doing should be considered before too much effort is spent on mechanical remediation.

The three major problem areas mentioned thus far, (1) technology as panacea, (2) packaged technology, and (3) mechanical problems, provide enough challenge to test the proposal. These are, of course, only examples and may not be the most pressing of concerns in many transfers. They are, however, clearly significant and of sufficient sweep to be taken seriously.

Intranational and International Transfer. The kind of project that causes instructional technologists to cringe usually involves an exhibition of naive faith in equipment. One recently observed language project involves, among other things, two terminals connected to a remote computer. The computer program cannot be modified by the teacher nor is the teacher involved in decisions related to program selection. The program has not benefited from field testing, the reading level is above that of the target population in the schools, and changes await the vendor-consultant who comes twice a month to work on problems. The serious part of the implementation of this packaged technology is the effect on the student. The program may not have the desired effect: one item asks the student to identify the complete sentence in a list of fragments. There is, of course, no complete sentence in the list. Another item instructs the student to put commas after answers. If the student puts the ccmma in the wrong place, the program registers a wrong answer and corrects the student as though a content error had been made. The teacher felt she had no control, was disengaged emotionally, and served as proctor rather than tutor.

The situation has most of the characteristics of packaged technology transferred into a setting without adaptation. Knowledge needed to adapt the program is centralized and to a large extent external to the recipient; the recipient does not know how to apply the technology; the technology as used does not fit the needs of the students; and so on. The setting is not, however, an unindustrialized country but the heart of an industrial metropolitan area in the Eastern United States. This parallel of problems may indicate that the needs of recipients in instructional technology transfer are similar.

Technology is rarely part of a knowledge cycle initiated in the field of education. Invention, development, commercialization, and initial markets are more often in business, industry, the military, or other government groups. Education is a secondary market. The technology comes to education in most districts in the same ways it comes to less industrialized countries. The differences between international and intranational instructional technology transfer are more in degree than in kind of problem.

The consequences of decisions are more serious in less industrialized areas with severe deficits in basics of life and little margin for error. If a program fails the loss includes both the sunk costs and the alternative opportunities that were bypassed. The undeveloped human potential is difficult to measure because progress is made up of several kinds of relative changes, many of them difficult to see. The causal relationships between educational treatments and outcomes are weak. This places analysis,

understandably, in areas such as politics and preferences rather than fact. Given severe consequences and little decision information, the medical maxim of "above all do no harm" may serve education well in technology transfer. Grand experiments may be best reserved for more industrialized countries.

Changing the System. Instructional development has made reference to "systems" from its beginning. The AECT glossary (1979) defines instructional development as "A systematic approach to the design, production, evaluation, and utilization of complete systems of instruction...." There has, however, been some confusion about the use of the work "systems." Unwin & McAleese (1979) conclude that the concept of "systems analysis" in technology is "virtually meaningless." At the same time, they quote Trotter's (1970) statement that "the over-riding imperative of technology is system." (Their saving grace is straightforwardly saying educational technology is not "an analytically precise concept.")

Some developers, particularly in production areas, define the concept "system" as "systematic practice." This approach flowered with the critical path network and PERT techniques. The emphasis is on predictability and convergence of performance. Another interpretation of "system" draws on biology with emphasis on process and change. It incorporates an entire society (Awa, 1979). This latter less precise definition will be used in the following discussion.

A system is dynamic and maintains its existance by balancing forces and movements. To survive a system must regain balance when disrupted. The multiple paths most social systems have to maintain this balance are complex, strong, and resilient. The transfer of instructional technology is a change in a system. The system resists change in a number of ways depending on the magnitude and stress involved. Further, instructional technology transfer is usually not a major force. The system will "right" itself without much effort.

Examples of other technology which have transferred would appear to counter this description. Automobiles, chain saws, or guns, however, are different in their visible and immediate effect. Even technology once removed, such as a hydroelectric dam, yield more observable product than a school television system. Skills that may be gained through some educational systems are difficult to causally relate to instructional technology in a way that has long term credibility. The combination of small perceived benefit and system balance mitigates against instructional technology. These "overriding social, political, and economic conditions, plus demographic changes, have made many educational projects ineffective and short lived" (Gallegos, 1982a).

Systems do change in education. And there are examples of successful instructional technology transfer. The audio tape cassette, hand held calculator, and overhead projectors have been transferred to education

in most industrialized areas. Unlike broadcast instructional television, these technologies could be and were adapted. An adaptation process seems to be related to successful transfer. Technology which can be adapted may find a function in the system. The transfer is a process of growing to fit.

Instructional Development. Instructional development has evolved rapidly. The practice, partly as a function of many academic practitioners, has been articulated, parsed, and modeled. Borrowing from psychology and building eclectically the jargon describing the process has become the lingua franca of instructional technology. This vocabulary of "needs assessments," "objectives," "evaluation," and so on provided a convincing way to talk about instructional technology. Outside interest grew, bright students became decision makers, and the few reflective pioneers such as Jim Finn were joined by many curious and thoughtful professionals.

Demonstrated effect in some projects, new technology, and the logical positivist orientation of the field were catalyzed by funding. The establishment and rapid growth of professional groups such as the Division of Instructional Development in AECT attest to this success. The attention to refining practice is understandable since the practice was florishing.

The focus of instructional development has also been shaped by clients. The largest single client has been the military. Large corporate training divisions and higher education have also had a growing demand for services.

The overlap of these three sectors has been extensive. Task orientation and training for specific purposes dominated the practice as it developed.

This process worked well in these settings and for these purposes, for which it is appropriate and should be further refined and nurtured. Most of the failures of technology are not because this process was used, but because no process was used. However, to make the assumption that this type of development will work in all areas because it works in some is to fly in the face of logic. As Schramm & Lerner (1976) observed about the old paradigm of communications development for countries, it lacks a necessary generality. The emphasis on intensive capital where capital is in short supply is one important difference. Labor saving projects where there is a surplus of labor is a second related problem. And, development in industrialized areas is often implementation. The design and development are more closely related to logistical planning than to invention. The design and development of a television system, for instance, may miss the most important kinds of development with respect to the context of a different society. Arnove (1976) is an excellent example of this. Three major stages in the decision making processes related to educational television are laid out. They are (1) the needs assessment, (2) the solutions selection, and (3) the strategic planning stage. This is a logical sequence but the title, Educational television: a policy critique and guide for developing countries, suggests a strong emphasis on implementation as well as a predestined solution.

The knowledge cycle traced earlier helped illustrate the selective development of technology to fit known settings. The transfer of the technology to different settings may be hindered by factors unimportant in the original setting. The technology also may lose important support factors in the transfer. If this is true of equipment and its use it may also be true of instructional development. The praxis was developed in a specific setting and served specific purposes.

The existence of similar factors is misleading because the degree of importance may differ greatly. Curiousity and a mystique related to equipment, for instance, is common to most settings. Yet it is not difficult to find examples where actual use of the equipment is deferred to the lowest clerical level. The Western executive who is so technologically ignorant he can't type suggests this is a problem in all cultures. The difference in degree, however, is greater than this small similarity.

There is a great temptation to transfer an instructional development process developed in a Western industrialized setting to a setting that appears to need what the West has. As a counter to this, it is reasonable to point out than most of the West's advantages did not spring from the use of instructional technology. Next, it is easy to argue for universal applicability since the concept of instructional development includes almost everything. The selective development of the process, however, may emphasize less desirable aspects, such as rapidly focusing on implementation, that are not as appropriate when practiced in a less industrialized region. How, then, should development be practiced: What is an alternative process?

> "the objective for developing nations is to establish developmental policies that are in harmony with the environment, related to social needs, and that foster self-reliance"
>
> Amulya Reddy, 1977

Development as Reinvention. "Reinventing the wheel" has always been a popular activity. The process is not, as often implied, wasted effort (Rice and Rogers, 1980). The "reinventor" learns more than the user about the technology. The process refines and sometimes redirects the technology. Yet the most important aspect of reinvention may not be the technical aspect as much as the involvement of the reinventors. The ownership that occurs with investment of time and effort frequently has more to do with success than the superiority of the technology.

Reinvention is change in the process of adoption and implementation after original development (Rogers, 1976; Larson and Agarwala-Rogas, 1977). It appears to be an important process for finding uses for technology which is transferred simply because it exists and funds are available, what Rice and Rogers (1980) call "technology-initiated" adoptions. Perhaps "funding-initiated" adoption or innovation describes the phenomenon as well.

Reinvention makes less assumptions about the outcomes of the technology transferred. However, the few assumptions the approach makes about process are critical. More direct responsibility shifts to the recipient and, as a result prediction becomes speculation. The sponsor yields control to the recipient. One assumption, which is near an article of faith, is that society will change and many of those reasons are better identified from

within the society. That is, an internal change agent can select the aspects of the technology which fit the situation. Much of this decision making is cultural, difficult to quantify, and intuitive or subconscious.

Another assumption is that the recipient will undertake reinvention. This is a dubious assumption for most instructional technology in most less industrialized areas. There is, as mentioned earlier, considerable immediate pressure for quick solutions to problems. Impatience with long term development of solutions is not, however, reserved to less industrialized areas. When American business classifies any projection of more than five years as long term, one suspects the problem is common to human affairs rather than peculiar to education or other countries. Problematic though this assumption is, the alternatives which implement and support a quick solution are not more likely to succeed. That is at least as clearly demonstrated as the existence of belief in "off the shelf" solutions. As with many dilemmas, the decision is between alternatives that are less than optimum.

Development which starts with reinvention is different in emphasis than the kind of implementation-oriented development familiar in industrialized settings. In reinvention, the recipient builds a store of knowledge in the adaptation process that is appropriate to that setting. The reinvention process does not require a large scale implementation. In fact, a large scale implementation may work against this process because the priority to get a system working minimizes tolerance for practices that are not directly related to preconceived goals.

On the face of it, the reinvention process appears to be a time consuming method of development. Compared to invention, however, it seems reasonable. It is also expensive compared to direct transfer implementation costs. Costs are less predictable, results are not forcastable, and there is less control by doners and the technology mavens. The process assumes the recipients can, given basic support, manage their own affairs.

The basic support for reinvention is similar to that needed for invention. There are, of course, many intangibles and unknowns and no attempt will be made here to add to the extensive literature on creativity and invention...or even to reflect the major findings. Instead, a few conditions that appear to be important and in conflict with convergent development models will be identified. (See also appendix A.) This should help heighten the contrast between the approaches. The following conditions are a tentative initial list.

1. Time: Reinvention is slower than implementation and early results are unlikely

2. Acceptance: Patience with failures rather than blame and accountability

3. Information: Reinventor need more than an instruction booklet. References, working models, and much applied knowledge are needed.

4. Critical mass: Invention and reinvention benefit from people getting together and sharing information and ideas

5. Resources: This is a need for real venture capital: it must extend over time and be flexible in use.

Compare these conditions with the kinds of advantages usually emphasized for convergent development. Convergent development emphasizes efficiency in

time, reduction of failures, use of only necessary information, and transfer of technology as money saving since research and invention costs are eliminated. The setting for training where the task is known, such as the military or assembly lines, fits with this approach. Where the task is less clear, or it is presumptive to speculate, it does not fit.

Development as adaptation or reinvention offers a smaller target for problems usually associated with technology transfer. The three mentioned earlier, (1) technology as panacea, (2) packaged technology, and (3) mechanical problems, are not eliminated, but there is a significant change in perspective. If technology is presented as "raw material" for the reinvention process the "quick fix" impression will be reduced. The lack of preconceived goals makes the technology less interpretable as a panacea. Panaceas will be sought, but the tendency to support that myth will be reduced. Packaged technology is closely associated with large scale systems. In such transfers, a product is being sold rather than a process. With reinvention, the emphasis is reversed: the recipient would get one piece of equipment and a hundred books instead of a hundred pieces of equipment and one book. Mechanical problems would still exist but the purpose of reinvention would be to adapt the technology to fit the setting instead of adopting the technology and trying to adjust the setting.

Policy Implications. An idea, regardless of its worth, is rarely successful on its own merits. For an idea to put into action, usually a decision maker has to be persuaded of its worth. It is then incorporated into a process and used by others. If development is going to be a process for reinvention and adaptation the easiest place to start is with major donor agency policy. This includes organizations such as the World Bank or Agency for International Development. It also should include government funded R&D agencies for intranational reinvention and private donor agencies such as the Ford Foundation. The effect of such agencies on the kinds of projects undertaken and the conditions under which they operate is enormous. For instance, the long period of funding for less industrilized areas to "catch up" by adopting new technology was promulgated by such agencies. From that period of high hopes in the 1950s we have become more and more cautious, realizing that the growth rates are, in fact, close to zero (Landes, 1980). Right or wrong, "these agencies and foundations have had an important and, in some cases, profound influence on educational development efforts at both the national and local levels" (Gallegos, 1982a).

The funding given for most instructional technology projects is for specific technologies to be implemented (Ofori-Ansah, 1982). Decreasing the emphasis on specific technology or at least on implementation and increasing the emphasis on adaptation by the length and level of funding would create conditions where reinvention is more probable.

A cautious approach unlikely to do harm would be to offer assured minimal funding for an extended period. This would remove stress for immediate results and limit capacity to make big mistakes unless local funding is used. In this gradual mutual adaptation the technology can be fitted to the society.

As a kind of "negative" policy, funding for large scale projects for implementation could be discouraged as funding is directed to funding reinvention. If reinvention is successful, and it may be hard to recognize, a second stage of funding may be appropriate.

The key emphasis is that funding would go to build the capacity of people in the recipient country, the "human resources" so needed in any successful venture. The equipment furnished would be for "play." The objective is to "reinforce the capability of the developing countries to manage their own development processes" (Casse, 1980).

_____ It deserves a try, preferable one which is minimally funded, not pressed for outcomes, people centered, and secure over an extended period of time.

Appendix A
Creativity and Adaptation

The difficulty in adapting through implementation of a clearly stated project is suggested by the following conclusions on problem solving and creative thinking. All are from an old textbook by Berelson, B. & Steinger, G., Human behavior. New York: Harcourt, Brace & World, 1964, pp. 201-207.

1. Novel solutions are rarely approached through overt, gradual, step-by-step approximation, with each step slightly closer than the preceding one; solutions seem to be attained or approached suddenly, or in spurts, after periods of futile attempt or even overt inactivity.

2. The solution to a complex problem is generally apprached via several increasingly specific considerations, starting with a general scanning of the class of possible approaches, moving to a selection of one or more "funditonal solutions," and then narrowing one or more of these into specific, operational solutions.

3. Problems are difficult to solve when they require the use of the familiar in an unfamiliar way.

4. The more recently an object has been used in its familiar function, the greater the tendency to overlook the novel use.

5. Specific solutions learned in one situation tend to impede or prevent the discovery of different approaches when a new situation demands them.

6. General solutions or principles that have proven successful may stand in the way when they are not appropriate in a situation like those in which they have been effective

7. The interfering influence of the familiar extends even to situations where the subject is presumably confined to rigid rules of thought that should exclude it.

8. Solutions can be impeded or prevented by erroneous and unconscious perceptual assumptions regarding the "inherent" limitations of a problem.

9. Solutions can be suggested by perceptual clues, even when the clues are not consciously recognized.

These suggest that solutions to new problems are confounded by previous experience and expectations of a technology.

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